Effect of Nitrogen and Sulphur on the Performance of Blackgram (*Vigna mungo* L.) under Custard Apple (*Annona squamosa* L.) based Agri-Horti System

Sheelendra Kumar[1], Makhan Singh Karada[1]*, Jiwan Paudel[2] and U. P. Singh[1]

[1]Department of agronomy, Institute of Agricultural Sciences, B.H.U. Varanasi-221005, India
[2]Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur 231001, UP, India

*Corresponding author

A B S T R A C T

A field experiment was carried out during Kharif season of 2018 to evaluate Effect of nitrogen and sulphur on the performance of blackgram under custard apple (*Annona squamosa* L.) based agri-horti system. The result indicated that Number of nodules plant^{-1} decreased drastically from 30 to 50 DAS of crop. The maximum root nodules plant^{-1} was found at highest nitrogen (40 kg N ha^{-1}) and sulphur level (40 kg S ha^{-1}) followed by, medium and over control at 30 and 50 DAS. The maximum dry matter accumulation plant^{-1} was observed at 40 kg N and 40 kg S ha^{-1} whereas; lowest dry matter accumulation was found under control. Increasing levels of N and S from control to 40 kg N ha^{-1} and 40 kg S ha^{-1} significantly increased the grain yield, stover yield, biological yield and harvest index of blackgram. The N and S contents in grain and stover of blackgram significantly improved due to 40 kg N ha^{-1} and 40 kg S ha^{-1} whereas, minimum was found under control (0 kg N and 0 kg S ha-1). The nutrient uptake in grain and stover of blackgram under custard apple based agri-horti system, increased markedly with increasing levels of nitrogen and sulphur and uptake highest with 40 kg N ha^{-1} and 40 kg S ha^{-1} and lowest uptake was found under control. Protein content and protein yield were found statistically superior with 40 kg N ha^{-1} and 40 kg S ha^{-1} while minimum was noted in control condition. The maximum gross returns (Rs 55,468 ha^{-1}), net returns (Rs 26,472 ha^{-1}) and benefit: cost ratio (1.94) were obtained with 40 kg N ha^{-1}, although, maximum gross returns (Rs 54887 ha-1), net returns (Rs 24371 ha^{-1}) and benefit: cost ratio (1.83) was maintained by 40 kg S ha^{-1} and minimum net returns (Rs 17719 ha^{-1}) and benefit: cost ratio (1.38) in control condition.

Introduction

Black gram (*Vigna mungo* L.) is a widely grown legume that belongs to the fabaceae family and assumes considerable importance from the point of view of food and nutritional security in the world. It is a favorable short-term pulse crop as it thrives better in all seasons either as a sole crop or as an intercrop or fallow crop. India is the world's largest producer and consumer of black gram. It produces about 1.5-1.9 million tons of black grams per year from about 3.5 million hectares of an area, with an average productivity of 600 kg ha^{-1} and its output accounts for about 10 percent of India's total pulse output. Black gram is a perfect combination of all nutrients, including

proteins (25-26 percent), carbohydrates (60 percent), fat (1.5 percent), minerals, amino acids and vitamins (Karamany, 2006).

Custard apple (*Annona squamosa* L.) belongs to the Annonaceae family, which includes more than 2000 species of mostly tropical trees and shrubs. The most frequently eaten species is simply referred to as the custard apple. It is native to tropical America and West Indies. Custard apple is grown in the tropics and subtropics of America, New Zealand, India, Brazil, Argentina, and Venezuela. In India it is mainly cultivated in states such as Andhra Pradesh, Maharashtra, Karnataka, Assam, Bihar, Orissa and Tamilnadu. Custard apple is a nutritive fruit due to the fact that its 100 gram edible portion contains 1.5 per cent of protein, 23.5 per cent carbohydrates, 17 mg calcium, 47 mg phosphorus, 1.5 mg iron, 0.07 per cent thiamine, 0.17 mg riboflavin, 1.3 mg niacin and 37 mg ascorbic acid (Shrivastava and Kumar, 1998).

Nitrogen is an essential plant nutrient involved in physiological processes and enzyme activity. The nitrogen requirement of pulses is very low than other crops because it requires nitrogen only for plant establishment, after which the plant fulfill its requirement through symbiotic nitrogen fixation. Normal metabolic activities can only continue in the presence of optimum nitrogen levels. Sulphur is considered to be the major plant nutrient after nitrogen, and its low availability in various soils causes an inherent sulphur deficiency. Sulphur plays a vital role in plant growth as well as legume metabolism. It is a part of nitrogenase enzymes, promoting leguminous nodulation. An adequate supply of sulphur can drastically reduce what enhances biological N-fixation (BNF) and pulse productivity. Sulphur plays very important role in Chlorophyll formation and also helps in biosynthesis of oil, carbohydrate,

protein and fat metabolism (Das etal.2016). Sulphur influences the growth of plants in two ways, first by acting as a nutrient and secondly by improving the favorable soil condition.

Materials and Methods

The experiment was conducted at the Rajiv Gandhi South Campus Agricultural Research Farm, Barkachha (BHU) Mirzapur, located in the Vindhyan district of Mirzapur (25010" latitude, 82037" longitude and 427 meters above sea level), covering an area of more than 1000 ha-1. where a variety of crops such as agricultural, horticultural, medicinal and aromatic plants are grown. Vindhyan soil is rainfed and has an invariably poor fertility status. This region is covered by agro-climatic zone III A (semi-arid eastern plain zone) and the region is mostly rainfed. Experiment was laid out in a factorial randomized complete block design with three replication during rainy Kharif season of 2018 in eleven years aged Custard Apple tree which were planted in August 2008 at a spacing of 5×5 m2. Blackgram was sown as intercrop in the alleys of custard apple tree. Each replication was divided into 12 equal plots and treatment was randomly allocated within the block for each replication. The treatment comprising of T1- 0 Kg/ha Nitrogen + 0 Kg/ha Sulphur (N1S0), T2- 0 Kg/ha Nitrogen + 20 Kg/ha Sulphur (N1S1), T3-0 Kg/ha Nitrogen + 30 Kg/ha Sulphur (N1S2), T4- 0 Kg/ha Nitrogen + 40 Kg/ha Sulphur (N1S3), T5- 20 Kg/ha Nitrogen + 0 Kg/ha Sulphur (N2S0), T6- 20 Kg/ha Nitrogen + 20 Kg/ha Sulphur (N2S1), T7- 20 Kg/ha Nitrogen + 30 Kg/ha Sulphur (N2S2), T8- 20 Kg/ha Nitrogen + 40 Kg/ha Sulphur (N2S3), T9- 40 Kg/ha Nitrogen + 0 Kg/ha Sulphur (N3S0), T10- 40 Kg/ha Nitrogen + 20 Kg/ha Sulphur (N3S1), T11- 40 Kg/ha Nitrogen + 30 Kg/ha Sulphur (N3S2), T12- 40 Kg/ha Nitrogen + 40 Kg/ha Sulphur (N3S3). The desired amount of

nitrogen and sulphur were applied just before sowing in furrow opened by spade below near about 5 cm deep. The seeds of variety "URD KUG-479" were sown on 11/08/2018 manually in the rows operated by kudal at a row distance of 30 cm apart; harvesting was done on 10/11/2018.

Soil characteristics

The physical properties of soil includes course sand (%) 10.35, fine sand (%) 48.32, silt (%)19.42, clay (%)21.97, textural class sandy clay loam (Typic Ustochrepts), bulk density (Mgm^{-3}) 1.26, particle density 2.47 Mgm^{-3}. Similarly chemical properties includes pH (1:2.5, soil and water ratio) 5.9, Electrical conductivity(1:2Soil: Water suspension)(dSm^{-1} at 25^{0}C) 0.31, Organic carbon (%) 0.49, Available nitrogen 153.32 kg ha^{-1}, Available phosphorus (kg ha^{-1}) 14.15, Available potassium 217.58 (kg ha^{-1}), Available sulphur 12.14kg ha^{-1}.

Chemical analysis of plant sample

For estimation of nitrogen and sulphur representative samples of seed and stover were taken at the time of threshing. Each dried stover sample was grind in fine powder in Willey mill for estimation of nutrient content. Protein content in seed was calculated by multiplying the nitrogen percentage with 6.25. The 0.5 g oven dried plant sample digested and nitrogen was estimated by the micro-Kjeldahl method Jackson (1973). The percentage nitrogen was multiplied with seed and stover yield into obtained Nitrogen uptake in kg ha-^{1}. The sulphur content in the digested plant samples was determined by turbidity methods acid yellow colour, using spectrophotometer at 340 nm wave length Chesnin and Yien (1950). The percentage sulphur was multiplied with seed and stover yield to obtained sulphur uptake in kg ha^{-1}.

Results and Discussion

Maximum plant height was observed with 40 kg N ha^{-1} which was found significantly superior over 20 kg N ha^{-1} and control at 40, 60 DAS and at harvest (Fig. 1).

Among the different level of sulphur, plant height was recorded highest in 40 kg S ha^{-1} and found significantly superior than 0 kg S ha^{-1} and 20 kg S ha^{-1} but it was found to be at par with 30 kg S ha^{-1} at 40, 60 DAS and at harvest (Fig. 2).

With the increase in nitrogen dose, the number of nodules plant^{-1} increased correspondingly over rest of nitrogen levels at 30 DAS. Whereas, at 50 DAS, 40 kg N ha^{-1} was found statistically at par with 20 kg N ha^{-1} and significantly superior over control (Fig. 3). All the sulphur levels showed marked differences in number of nodules plant^{-1}. At 30 DAS, Highest sulphur level was differing significantly over rest of sulphur doses and over control. The highest dry matter accumulation plant^{-1}was found at 40 kg N ha^{-1} (Fig. 4).

And it was statistically superior over 20 kg Nha^{-1} and control whereas, 40 kg S ha^{-1} maintained maximum dry matter accumulation at harvest over rest of the sulphur doses and over control (Fig. 5). Highest test weight (32.29) was found with 40 kg N ha^{-1}. However differences among the different nitrogen levels, test was couldn't touch the levels of significance. As regards the four levels of sulphur, 40 kg S ha^{-1} recorded higher test weight (32.41). Increasing levels of nitrogen from 0 kg N ha^{-1} to 40 kg N ha^{-1} markedly increased the grain yield. However, the differences among the nitrogen levels, 40 kg N ha^{-1} recorded significantly higher grain yield (777 kg ha^{-1}) which was found 6.69 per cent and 17.24 per cent more over 20 kg N ha^{-1} and over control (Table 1).

Table.1 Effect nitrogen and sulphur on grain yield, stover yield, biological yield and harvest index of blackgram under custard apple based agri-horti system

Treatment	Yield			
	Grain yield (kgha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
Nitrogen level (kg ha^{-1})				
N$_1$- 0kg	643	1669	2312	27.80
N$_2$- 20kg	725	1837	2562	28.24
N$_3$- 40kg	777	1963	2741	28.33
SEm±	12	28	39	0.24
CD (P= 0.05)	37	84	115	0.71
Sulphur level (kg ha^{-1})				
S$_0$- 0kg	640	1691	2332	27.51
S$_1$- 20kg	706	1807	2514	28.07
S$_2$- 30kg	744	1845	2590	28.61
S$_3$- 40kg	769	1949	2718	28.30
SEm±	14	33	45	0.28
CD (P= 0.05)	43	97	132	0.82

Table.2 Effect of nitrogen and sulphur on Nitrogen and sulphur content of blackgram under custard apple based agri-horti system

Treatment	Content (%)			
	Grain		Stover	
	N	S	N	S
Nitrogen level (kg ha^{-1})				
N$_1$- 0kg	3.69	0.67	1.15	0.35
N$_2$- 20kg	3.86	0.68	1.32	0.51
N$_3$- 40kg	4.12	0.92	1.55	0.66
SEm±	0.04	0.05	0.02	0.03
CD (P= 0.05)	0.12	0.15	0.07	0.09
Sulphur level (kg ha^{-1})				
S$_0$- 0kg	3.58	0.39	1.15	0.20
S$_1$- 20kg	3.68	0.50	1.23	0.37
S$_2$- 30kg	3.96	0.81	1.42	0.58
S$_3$- 40kg	4.34	1.34	1.55	0.88
SEm±	0.05	0.06	0.03	0.04

Table.3 Economics of blackgram as influenced by N and S levels under custard
apple based agri-horti system

Treatment	Cost of cultivation (ha^{-1})	Gross return (ha^{-1})	Net return (ha^{-1})	B:C ratio
Nitrogen level (kg ha^{-1})				
N$_1$- 0kg	28249	45968	17719	1.62
N$_2$- 20kg	28715	51724	23010	1.80
N$_3$- 40kg	28996	55468	26472	1.94
SEm±		886	886	0.03
CD (P= 0.05)		2598	2598	0.09
Sulphur level (kg ha^{-1})				
S$_0$- 0kg	26233	45858	19625	1.75
S$_1$- 20kg	28414	50459	22045	1.77
S$_2$- 30kg	29451	53010	23560	1.80
S$_3$- 40kg	30515	54887	24371	1.83
SEm±		1023	1023	0.01
CD (P= 0.05)		3000	3000	0.03
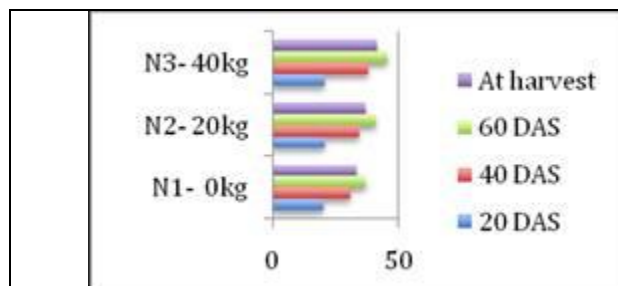
Fig.1 Effect of nitrogen on plant height (cm) of blackgram under custard apple based agri-horti system
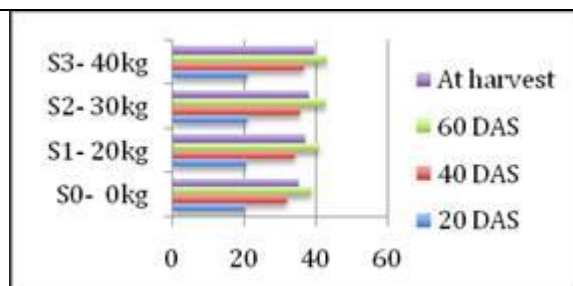

Fig.2 Effect of sulphur on plant height (cm) of blackgram under custard apple based agri-horti system
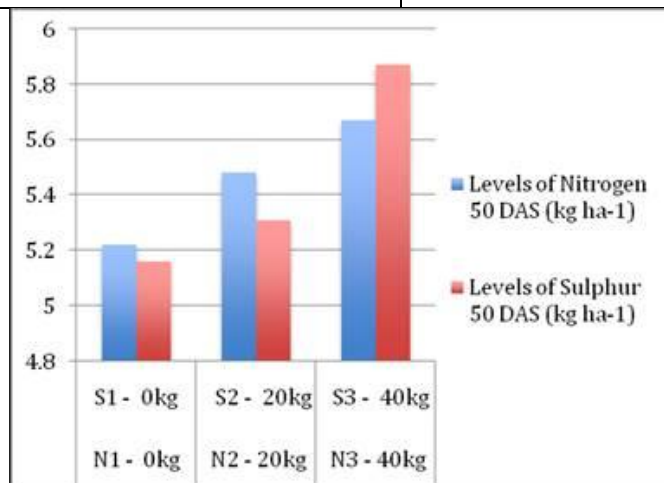

Fig.3 Effect of nitrogen and sulphur on root nodules plant^{-1}(No.) of blackgram under custard apple based agri-horti system
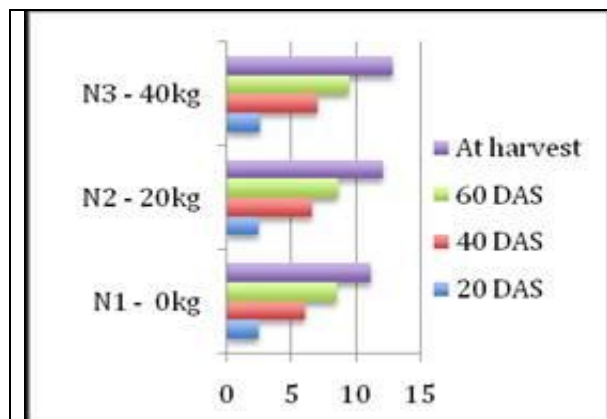
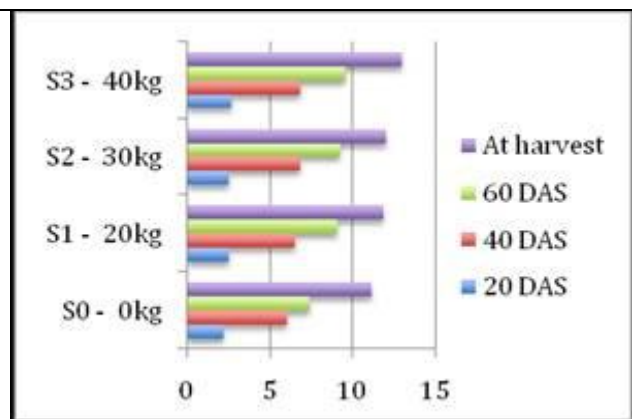| **Fig.4** Effect of nitrogen on dry matter accumulation (g. plant^{-1}) under custard apple based agri-horti system | **Fig.5** Effect of Sulphur on dry matter accumulation (g. plant^{-1}) of blackgram under custard apple based agri-horti system |

Highest dose (40 kg S ha^{-1}) of sulphur produced significantly highest nitrogen content in stover of black gram, than by 30 kg S ha^{-1}, 20 kg S ha^{-1} and over control. Increasing levels of nitrogen application from 0 kg N ha^{-1} to 40 kg ha^{-1}, significantly increased the sulphur content in stover. Highest sulphur level (40 kg S ha^{-1}) was maintained higher sulphur content (0.88 per cent) over 30 kg S ha^{-1}, 20 kg S ha^{-1} and control (Table 2).

Due to different nitrogen levels protein content was found maximum (25.77) in 40 kg N ha^{-1} and showed distinctive significant characters over control. Highest levels of sulphur (40 kg S ha^{-1}) produced significantly higher protein content and protein yield over 30, 20 kg S ha^{-1} and over control.

Economics

Highest nitrogen level 40 kg ha^{-1} significantly recorded highest gross return (Rs. 55,468 ha^{-1}) followed by 20 kg N ha^{-1} (Rs. 51,724 ha^{-1}) and over control (Rs. 45,968 ha^{-1}). Data regarding different sulphur levels, highest sulphur level (40 kg S ha^{-1}) produced maximum gross return (Rs. 54,887 ha^{-1}) and found significantly superior over the rest of the treatments. increasing levels of nitrogen

from lowest to highest, maintained significantly increased net returns (Rs. 26,472 ha^{-1}) over the rest of the treatments (Table 3).

Highest net returns (Rs. 24,371 ha^{-1}) was noticed due to highest sulphur level (40 kg S ha^{-1}) and found significantly superior over 30, 20 kg S ha^{-1} and control. Highest level of nitrogen (40 kg S ha^{-1}) produced maximum benefit cost ratio (1.94) over the 20 kg N ha^{-1} and control and highest sulphur level (40 kg S ha^{-1}) produced highest benefit cost ratio (1.83).

Based on the experimental results and economics, it could be recommended that growing of blackgram along with nitrogen 40 kg ha^{-1} and sulphur 40 kg ha^{-1} intercropped in alley of custard apple may be beneficial for boosting grain yield, higher net return, maximum benefit cost ratio and better profitability in the Vindhyan region of Mirzapur.

References

Chesnin L, Yien CH (1950) Turbidimetric determination of available sulphates. *Soil SciSoc Am Proc* 15: 149– 151

Das SK, Biswas B, Jana K. Effect of farm

yard manure, phosphorus and sulphur on yield parameters, yield, nodulation, nutrient uptake and quality of chickpea (*Cicer arietinum* L.). J Appl. & Nat. Sci. 2016; 8(2):545- 549.

Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi.

Karamany EL (2006). Double purpose (forage and seed) of mung bean production 1- effect of plant density and forage cutting date on forage and seed yields of mung bean (*Vigna radiata* (L.) Wilczck). Res. J. Agric. Biol. Sci. 2: 162-165.

Shrivastava, R.P. and Kumar, S. 1998. Fruits and vegetable preservation principles and practices. International Book Distributing Company, Lucknow.

How to cite this article: